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Review

WEEDS AND WEED MANAGEMENT IN CONSERVATION AGRICULTURE (CA) INFLUENCED BY ITS THREE PILLARS AND HERBICIDES[#]

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CA is based on three large pillars: reducing or eliminating tilling, covering the soil, diversifying crop rotations. One of the most difficult management issues within this system are weeds and proper weed management. CA brings a shift in dynamics of the weed seed bank, weed populations, density and growth, requiring clear understanding and formulating a strategy for their management. Crop residues influence weed seed germination and seedling emergence by interfering with sunlight availability and suppression through physical and chemical allelopathic effects. Cover crops are fundamental and sustainable tools to manage weeds reducing their numbers physically and chemically. Diversification of the crop rotation help to disrupt the growing cycle of weeds, and prevent any weed species to dominate. Herbicides are an integral part of weed management in CA, as well. When herbicides are not used at appropriate rates or in rotation caused environmental pollution, weed shift, and resistance development in some weeds.

Key words: CA; weeds; crop residues; cover crops; crop rotation

REASONS FOR CA APPEARING AND ITS PILLARS

Conventional tillage (CT) has been an integral part of crop production since crops were first cultivated. Some historians have even evaluated the progress of agrarian societies by their developments in tillage. The premise for CT was to subdue or destroy native vegetation so desired plants might develop free from competition. From the onset of agriculture, CT was synonymous with seedbed preparation and weed control [1]. Apart this, CT is used for crop establishment in order to loosen and aerate the soil for planting, incorporate crop residues and nutrients, enhance the release of nutrients from the soil for crop growth, regulate the circulation of water and air within the soil [2, 3] and when carried out in autumn/winter expose the soil to frost in order to benefit soil structure [4].

Nevertheless CT practices often increase soil erosion rates leading to deteriorating soil physical, chemical and biological properties [5], reduced soil quality such as soil structure, with consequences for water infiltration [6], poor soil porosity, nutrient loss and low organic matter content [7], lead to increased greenhouse gas emissions [8] and create hard pans below the plough layer, as well [9]. Poor soil nutrient statuses in combination with poor weed management practices often contribute to decreased yields [10]. To alleviate this challenge, researchers have suggested a more sustainable method of farming, commonly referred to as Conservation Agriculture (CA).

CA (synonymous of zero tillage farming or no-tillage farming, ridge-till, mulch-till, and noninversion tillage) emerged historically as a response to soil erosion crises in the USA, Brazil, Argentina and Australia where currently, it spans over million hectares. The vulnerability of plough-based agriculture was exposed during the Dust Bowl era (1931-39); as the wind blew away the precious top soil from the drought-ravaged southern plains of the US, leaving behind the failed crops and farms. However, there was no answer then to solve the question of soil

[#]Dedicated to academician Gjorgji Filipovski on the occasion of his 100th birthday degradation. Then, what *Nature* magazine termed "an agricultural bombshell" was dropped by Edward Faulkner on July 5, 1943; with the first issue of his masterpiece book "*Plowman's Folly and A Second Look*" [11]. This book was a milestone in the history of agricultural practices—he questioned the wisdom of ploughing. Some of his statements are: "No one has ever advanced a scientific reason for plowing"; "There is simply no need for plowing in the first instance. And most of the operations that customarily follow the plowing are entirely unnecessary, if the land has not been plowed"; "There is nothing wrong with our soil, except our interference"; and, "It can be said with considerable truth that the use of the plow has actually destroyed the productiveness of our soils." The statements were questioned by both farmers and researchers because alternatives to ploughing at that time did not allow farmers to control weeds or plant into the residues [12]. The idea was widely embraced by farmers all across the world, particularly in the USA only after the Second World War, when the development of chemicals for agriculture allowed them to try it out. With the introduction of 2,4-D in the mid-1940s, producers were, for the first time, given an economical chemical alternative to tillage for preplant weed control. The introduction of numerous other herbicides in the succeeding decades allowed reduced and CA systems to become more feasible and popular [13]. CA systems are being advocated since the 1970s. However, the majority of CA expansion worldwide has occurred since the mid- to late-1990s [14]. This has been accelerated due to the development of efficient farm machinery and the availability of effective herbicides coupled with trained manpower, which have resulted in reduced production costs and higher profitability, besides several indirect benefits [15].

CA is a system designed to achieve agricultural sustainability by improving the biological functions of the agroecosystem with limited mechanical practices and judicious use of chemical inputs. According to FAO [16], CA is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely:

1. Continuous no- or minimal mechanical soil disturbance (i.e., no-tillage and direct sowing or broadcasting of crop seeds, and direct placing of planting material in the soil; minimum soil disturbance from cultivation, harvest operation or farm traffic, in special cases limited strip tillage);

2. Permanent organic soil cover, especially by crop residues, crops and cover crops to protect and feed the soil, develop surface mulch; and

3. Diversification of crop species grown in sequence or associations through rotations or, in case of perennial crops, associations of plants, including a balanced mix of legume and non legume crops to help moderate possible weed, disease and pest problems, generate biomass, fix atmospheric nitrogen and serve as nutrient pumps [17–19].

These three principles converge towards one central and stated goal: to reduce soil degradation and improve soil fertility, by preserving its organic matter, flora and fauna [20].

CA, particularly no-till (NT) system as the core principle of CA, offers a way of optimizing productivity and ecosystem services, offering a wide range of economic, environmental and social benefits to the producer and to the society. At the same time, no-till farming is enabling agriculture to respond to some of the global challenges associated with climate change, land and environmental degradation, and increasing cost of food, energy and production inputs [21–23].

BENEFITS AND LIMITATIONS OF CA

CA technologies are essentially herbicide-driven, machine-driven and knowledge-driven, and therefore require vastly-improved expertise and resources for adoption in large areas. Like every technology, CA mainly is characterized as beneficiary oriented, but it is faced with many challenges and limitations, as well.

A host of benefits can be achieved through employing components of CA, including reduced soil erosion (96 % less erosion) [24] and water run-off (reduction of 70 % in the volume of run-off) [25, 26], increased productivity through improved soil quality, soil water holding capacity increased [27], water availability, water infiltration and water use efficiency [21], reduced sediment and fertilizer pollution in lakes and streams, increased biotic diversity, reduced labour demands [18, 28, 29] and improved quality of life. Advantages also include climate change mitigation through reduced emissions due to 60–70 % lower fuel use, 20–50 % lower fertilizer and pesticides use, 50 % reduction in machinery and labour requirement [30], C-sequestration 0.85 t ha^{-1} y^{-1} or more [31], and no CO_2 release as a result of no burning of residues. Overall, CA has a much lower carbon footprint than CT agriculture [32], and greenhouse gas (GHG) emissions of CO_2, CH_4 and NO_2 are all reduced with CA [33–35]. Based on experiences from North and South America, increased soil C sequestration is reported as the chief reason for improved soil productivity with time under CA compared to CT fields [36]. Improved soil moisture conservation [6], reduced erosion, and increased biological activity [37], are all associated with residue retention. Crop rotation increases crop diversity, reducing crop yield penalties associated with insect damage, diseases and weed infestations whilst improving nutrient cycling [38].

Despite both environmental and production advantages offered through CA, adoption rates have previously lagged in many countries due to several factors including: availability of required equipment, lack of information, producer mindsets, and, initially, greater weed control problems, herbicide dependency [38, 39] and increased risk of herbicide resistance [40]. Other disadvantages include reduced spring soil temperature [41], increased pest problems (incidence of rhizoctonia disease, for example), risk of increased N_2O emissions and increased dissolved reactive P leaching, reduced reliability of crop yields, risk of topsoil compaction [42], and reluctance of farmers to accept the new practice [43]. Several factors including biophysical, socioeconomic and cultural limit the adoption of CA, particularly by resource-poor farmers. The current major barriers to the spread of CA systems are (i) competing use of crop residues in rainfed areas, (ii) weed management strategies, particularly for perennial species, (iii) localized insect and disease infestation, and (iv) likelihood of lower crop productivity if site-specific component technologies are not adopted [44, 45]

WEEDS IN CA SYSTEMS

Although benefits are context specific, CA has been identified as an effective tool for sustainably increasing yields in many parts of the world [21, 46], adopting CA will face several managerial changes, and weed control is perceived as one of the most challenging [5, 47–49].

CT has been a major agricultural weed control technique for several decades [50], so the development of CA systems that advocate NT or reduced tillage has significant implications for growers [51]. CT affects weeds by uprooting, dismembering, and burying them deep enough to prevent emergence, by changing the soil environment and so promoting or inhibiting the weeds' germination and establishment, and by moving their seeds both vertically and horizontally [52–54]. CT is also used to incorporate herbicides into the soil and to remove surface residues that might otherwise impede the herbicides' effectiveness. Reduction in tillage intensity and frequency, as practiced under CA, generally increases weed infestation and causes a variation in the dynamics of the weed populations [55].

Mishra and Singh [56] observed that over the course of time, an NT–NT sequence favoredrelatively higher weed growth over a CT–CT sequence in a rice–wheat system. While weed growth in the initial year was not higher under the NT–NT sequence, in the third year of experimentation total weed dry weight was significantly higher under the NT–NT than CT–CT tillage sequence. Total weed density was significantly lower (16.3 plants m^{-2}) under the CT than the other reduced tillage systems(36.7–39.2 plants m^{-2}). The main benefit of CT is a highly significant decline of perennial weeds. Only 2.6 perennial weed plants per quadrant in CT as compared to 7.5–9.0 in reduced tillage treatments were noted [57]. Tolimir *et al*. [58] also noted considerably lower weed infestation per square meter under CT (7 weeds) compared to reduced (39 weeds) and NT (46 weeds). Swanton et al. [59] found that tillage was an important factor affecting weed composition: *Chenopodium album* and *Amaranthus retroflexus* were associated with a CT system, whereas *Digitaria sanguinalis* was associated with NT.

Shifts in weed populations from annual large-seeded broadleaf to annuals grass and small-seeded broadleaf and perennials, as well have been observed in CA systems [60–63]. Perennial weeds thrive in reduced or NT systems [64, 65]. Most perennial weeds have the ability to reproduce from several structural organs other than seeds. Among them, perennial monocots are considered a greater threat than perennial dicots in the adoption of reduced tillage systems [11]. In practice, researchers have shown that small-seeded annual grass species and perennials become more difficult to manage as tillage is decreased, whereas large-seeded broadleaf weeds become easier to manage in production systems with less tillage [66]. For example, in ZT-DSR (zero-tillage- dry direct-seeding), weed flora often shifts towards more difficult to control and competitive grasses and sedges such as *Leptochloa chinensis* (L.) Nees, *Eragrostis* spp., *Echinochloa colona* (L.) Link., *Cyperus* spp., *Eclipta prostrata* (L.) L., *Ammannia* spp., *Sphenochloa zeylinica* Gaertn. [67]. Similar, in the Eastern Indo-Gangetic Plains, big and serious problems under NT are *Cyperus rotundus* L. and *Cynodon dactylon* (L.) Pers. [68]. According to Shaw *et al*. [1] winter annual and biennial weeds, and some brush species that were not problematic with CT can increase with NT, like *Cirsium arvense*, where NT leaves the roots undisturbed and *Cirsium arvense* populations can increase. Opposite, analysis of multiplied dominance ratio (MDR) of weeds in Japan showed that summer annual weeds, especially grass weeds, were much more abundant than perennial weeds in the NT fields [69].

Different tillage systems disturb the vertical distribution of weed seeds in the soil, in different ways. Studies have found that moldboard plowing buries most weed seeds in the tillage layer, whereas chisel plowing leaves most of the weed seeds closer to the soil surface [70]. In reduced or NT systems, depending on the soil type, 60–90 % of weed seeds are located in the top 5 cm of the soil [52, 54, 71]. Similar, the highest number of weed seed species was found in the treatments with reduced and NT treatments in a soil layer of 0–5 cm. In deeper soil layers (5–10, 10–20 cm), no differences in weed seed species number were found [72]. Chauhan *et al.* [73] reported that a low-soil-disturbance single-disc system retained more than 75 % of the weed seeds in the top 1-cm soil layer, whereas the high-soil-disturbance seeding system buried more than 75 % of the seeds to a depth more than 5 cm. Further, the accumulation of the weed seeds at the soil surface increases their chance to germinate in one season with suitable moisture and temperature, and they are exposed to insect predation, (vertebrates and invertebrates) [74] fungal and bacterial attack [75], rodents and birds consume [76] and decay thus depletion of the weed seed bank is high [77] as well as weed density [78]. Sagar and Mortimer [79] found that weed seed survival across time is lowest when seeds remain on the soil surface because of exposure to environmental extremes and predation. Similar, Usman *et al*. [80] concluded that there is a rapid loss of viability of weed seeds in addition to predation on the soil surface in NT compared to CT where seeds are buried in the soil and prevented from environmental hazards. Even in the absence of seed predators, weed seeds from species as diverse as *Panicum miliaceum* L., *Amaranthus retroflexus* L., and *Solanum sarrachoides* Sendtner have been shown to lose viability at a greater rate when positioned near the soil surface than when buried below the emergence zone [81, 82].

Although some studies found that weed seed bank, weed density and weed infestation are smaller in NT compared with CT, other studies claimed the opposite [83]. According to Singh *et al*. [11] the presence of weed seeds on the upper soil surface, due to no tillage operation, leads to higher weed infestation in the NT system. Cardina *et al*. [63] studied the weed seed bank size and composition after 35 years of continuous crop rotation and tillage system and concluded that weed seed density was highest in NT and generally declined as tillage intensity increased. The soil weed seed bank was 1.5 and 2.2 times greater in the shallow ploughing and shallow ploughless tillage treatments, compared with the CT treatment (deep ploughing). In the shallow ploughing and shallow ploughless tillage treatments, there were found 25.5 % and 41.5 % more weed seed species in the soil, compared with the CT treatment [84]. According to Menalled *et al*. [85], above ground weed biomass, species density, and diversity were lowest in the CT system, intermediate in the NT system, and highest in the low-input and organic systems. Higher weed seed densities in NT systems may be the result of reduced herbicides availability because of adsorption to near surface organic matter [86].

COVER CROPS AND THEIR RESIDUES

The use of cover crops in CA offers many advantages, one of which is weed suppression through physical as well as chemical allelopathic effects [87, 88], while actively growing or after termination [89]. Prior to termination, cover crops can compete with weed species for necessary resources such as light, water, and nutrients; cover crops can also release allelochemicals into the soil which may be detrimental to nearby competing weed species, particularly for small-seeded weeds [90]. Cereal rye (*Secale cereale* L.) and soft red winter wheat (*Triticum aestivum* L.) used as cover crops also contain allelopathic compounds that inhibit weed growth [91]. Yenish *et al*. [92] reported increased short-term weed control using a rye cover crop in NT corn (*Zea mays* L.) but not season-long control. In southern Brazil, black oat (*Avena strigosa* Schreb.) is the predominant cover crop on millions of hectares of NT soybean [*Glycine max* (L.) Merr.] because, in part, of its weed-suppressive capabilities [93]. In Japan, a possible goal of a cover crop system in NT soybean is to eliminate or greatly reduce the use of herbicides in association with the implementation of reduced tillage and the appropriate use of cover crops [69]. Two annual medic species [burr medic (M. *polymorpha* cv. Santiago) and barrel medic (M. *truncatula* Gaertn. cv. Mogul)], berseem clover (*Trifolium alexandrinum* L. cv. Bigbee), and medium red clover (*Trifolium pratense* L.) were NT seeded as cover crops into winter wheat (*Triticum aestivum* L.) stubble in a winter wheat/corn (*Zea mays* L.) rotation system. The density of winter annual weeds was between 41 and 78 % lower following most cover crops when compared with no cover control in 2 out of 4 site years, while dry weight was between 26 and 80 % lower in all 4 trial site years [94].

In CA systems, the presence of crop residue acting as mulches on the soil surface, influence soil temperature and moisture regimes that affect weed seed germination and emergence patterns over the growing season. Crop residues can influence weed seed germination and seedling emergence [95, 96]. Several mechanisms may contribute to reduced weed emergence and growth where surface cover crop residues are present, including reduction in light penetration to the soil [97], physical obstruction resulting in seed-reserve depletion before emergence [98], increased seed predation or decay [74, 99], decreased daily soil temperature fluctuations [101], or the production of allelopathic compounds [97].

Weed emergence generally declines with increasing residue amounts. However, the emergence of certain weed species is also favored by some crop residue at low amounts. For example, germination and growth of *Avena fatua* L. and *Avena sterilis* L. may get stimulated with low levels of wheat residue [11]. Further, late emerging weed plants produce fewer seeds than the early emerging ones [77]. For example, the residue of *Vicia villosa* Roth and *Secale cereal* L. reduced total weed density by more than 75 % compared with the treatments with no residue [100]. The presence of rye mulch in corn significantly reduced the emergence of *Chenopodium album* L., *Digitaria sanguinalis* (L.) Scap., and *Portulaca oleracea* L. and total weed biomass [101]. Tuesca *et al.* [102] attributed the lower densities of *Chenopodium album* L. under NT systems to the inhibitory effect of crop residues on light interception. Saini [103] found that rye residue provided 81–91% control of *Diodia virginiana* L. and *Jacquemontia tamnifolia* [L.] Griseb., *Digitaria sanguinalis* [L.] Scop. control was only 11 % in cotton and peanut.

For significant suppressive effects of mulch on the emergence and growth of *Echinochloa crus-galli* (L.) P. Beauv. and *Eclipta prostrata* (L.) L., 6 t ha^{-1} rice residue as mulch was needed, whereas, the emergence of *Echinochloa colona* (L.) Link and *Dactyloctenium aegyptium* Willd. was reduced with as little as 1 to 2 t $ha^{–1}$ [68]. Chhokar *et al.* [104] observed that 2.5 t $ha^{–1}$ rice residue mulch was not effective in suppressing weeds, but 5.0 and 7.5 t $ha^{–1}$ residue mulch reduced weed biomass by 26 to 46 %, 17 to 55 %, 22 to 43 %, and 26 to 40 % of *Phalaris minor* Retz., *Oxalis corniculata*. L., *Medicago polymorpha* L. and *Setaria viridis* (L.) P.Beauv., respectively, compared with ZT without residue. Similar, Chauhan and Abugho [96] reported that 6 t $ha^{–1}$ crop residues reduced the emergence of *Echinochloa colona* (L.) Link, *Dactyloctenium aegyptium* Willd. and *Cyperus iria* L. by 80–95 %, but only reduce the emergence of *Echinochloa crus-galli* (L.) P. Beauv. by up to 35 %. However, crop residues alone may not be able to fully control weeds, e.g. *Vicia villosa* residues suppressed weeds early in the growing season but herbicide was needed to achieve season-long weed control [11].

Unlike in the CT system, crop residues present at the time of herbicide application in CA systems may decrease the herbicide's effectiveness as the residues intercept the herbicide and reduce the amount of herbicide that can reach the soil surface and kill germinating seeds [51]. According to Chauhan *et al.* [105], crop residues can intercept 15–80 % of the applied herbicides and this may result in reduced efficacy of herbicides in CA systems.

DIVERSIFIED CROP ROTATION

Crop rotation increases crop diversity, reducing crop yield penalties associated with insect damage, diseases and weed infestations whilst improving nutrient cycling [38]. Crop rotations are arguably the most effective way to control weeds. It limits the build-up of weed populations and prevents weed shifts as the weed species tend to thrive in a crop with similar growth requirements. Different crops require different cultural practices, which help to disrupt the growing cycle of weeds and prevent any weed species to dominate [11]. In this way, any given crop can be thought of a filter, only allowing certain weeds to pass through its management regime [106]. Rotating crops will rotate selection pressures, preventing one weed from being repeatedly successful, and thus preventing its establishment [107]. Weed diversity has been shown to increase under crop rotation compared to monoculture [108, 109]. Greater diversity prevents the domination of a few problem weeds. Murphy *et al.* [110] observed the highest weed species diversity in NT fields with a three-crop rotation of corn–soybean–winter wheat. Weed species composition would be affected by rotation design, and weed population dynamics are very dependent on the crops included in the rotation [111]. The diversification of the system even for a short period and intensification by including summer legumes/green manuring decreased the weed menace [112]. The integration of red clover in the sweet corn–pea–wheat rotation led to a 96% reduction in the seed bank density of winter annuals [113]. Further, including perennial forages, such as alfalfa in rotation, has been shown to contribute weed control for up to three years, and can be particularly effective in NT systems [114, 115]. In NT systems of the Northern Great Plains of the United States (US) and Canada, stacked rotation designs offer superior weed control compared to yearly rotations [116]. Anderson and Beck [117] found that warm-season weeds were more prevalent in rotations with two warm-season crops in 3 years, whereas these species were rare in rotations that included 2-year intervals of cool-season crops or fallow. Similar, weed community density declined across time with NT when rotations consisted of two cool-season crops followed by two warm-season crops; in contrast, weed community density was 13-fold greater with a two-crop rotation and NT [118]. In that context, in the semiarid Great Plains, producers who rotated cool-season and warm-season crops reduced weed community density and could grow some crops without needing herbicides to achieve optimum yields. With these diverse rotations, producers are using 50% less herbicide to manage weeds compared with that in less-diverse rotations [118].

HERBICIDES IN CA

Herbicides have an important role in weed control under CA systems [55]. Restricting tillage reduces weed control options and increases reliance on herbicides in such production systems, particularly the recent development of post-emergence broadspectrum herbicides provides an opportunity to control weeds in CA [119]. Therefore, CA is presently a common farming system in many countries, principally because many types of herbicides are available [120]. The presence of weed seeds on the upper soil surface, due to no-tillage operation, leads to higher weed infestation in CA, and so far herbicides are the only answer to deal with this problem [11]. They play an important role, particularly in controlling weeds during the first years after the adoption of conservation agriculture [121]. Herbicides are effective weed control measures and offer diverse benefits, such as saving labor and fuel cost, requiring less human efforts, reducing soil erosion, saving energy, increasing crop production, reducing the cost of farming, allowing flexibility in weed management, and tackling difficult-to-control weeds [122, 123]. The use of herbicides to facilitate weed control and soil cover management is an option to reduce production costs and to avoid the aforementioned negative effects associated with soil tillage, including the stimulation of further weed emergence and spread. In Canada adoption of NT has not increased herbicide use significantly [124], and in the US Great Plains, NT wheat systems have controlled weeds using cultural tactics and reduced herbicide usage by 50% compared to CT [118]. Similar, in some West European countries [125] and some areas in Australia [126], which have agroecological conditions similar to Europe, herbicide use per tonne of output is lower in CA systems with integrated weed management than in CT farming [127]. Published research on NT corn and soybean showed that preemergence herbicide use for summer annual weed control could be reduced 50 % by banding herbicides over crop rows and substituting between row mowing for herbicides [128–130]. This equaled a 50 % reduction in preemergence herbicide use and a 25 % reduction in total herbicide use in no-till. In corn and soybean, crop yields were statistically indistinguishable among weed-free checks, broadcast preemergence herbicide treatments, and some treatments using banded preemergence herbicide followed by between-row mowing. Similarly, NT with effective herbicide weed control was more remunerative in the soybean–wheat system [131]. Further, the application of a burndown herbicide such as paraquat or glyphosate at planting followed by a herbicide such as Harmony Extra (Thifensulfuron-methyl+ Tribenuron-methyl) in the spring excellent solve the problems with broadleaved weeds no-till wheat [132]. Herbicide treatments such as glufosinate, mesotrione, and dicamba + diflufenzopyr are effective in suppressing *Taraxacum officinale* Web. competition in no-tillage corn [133].

However, to sustain CA systems, herbicide rotation and/or integration of weed management practices is preferred as continuous use of a single herbicide over a long period of time may result in the development of resistant biotypes, shifts in weed flora and negative effects on the succeeding crop and environment [11, 134]. Selection pressure imparted by herbicide tactics can result in weed shifts attributable to the natural resistance of a particular species to the herbicide or the evolution of herbicide resistance within the weed population [55]. Reddy [135] found that continuous bromoxynil-resistant cotton production resulted in weed species shift toward *Portulaca oleracea* L., *Senna obtusifolia* [L.] Irwin and Barneby, and (*Cyperus esculentus* L.).

A major criticism of CA is its enhanced reliance on herbicides as compared to tilled systems. In particular, glyphosate may be heavily used, especially to control perennial weeds [136]. When herbicides are not used at appropriate rates or in rotation [40], it can lead to the development of herbicide resistance among major weed species [137,138]. Herbicide resistance and weed control problems are clearly the main reasons given by adopters for past or intended reductions in NT use [139]. Herbicide resistance and weed control issues are the major reason why some NT adopters are reducing their use of NT as the core principle of CA.

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ВЛИЈАНИЕ НА ТРИТЕ СТОЛБА НА КОНЗЕРВАЦИСКОТО ЗЕМЈОДЕЛСТВО И ХЕРБИЦИДИТЕ ВРЗ ПЛЕВЕЛИТЕ

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Конзервациското земјоделство е засновано на три големи столба: редуцирана обработка или целосно нејзино елиминирање, покриеност на почвата и разновиден плодоред. Еден од најголемите проблеми со кои се соочува овој систем се плевелите и правилната борба против нив. Конзервацискиот систем предизвикува промена во динамиката на плевелните семиња во почвата, плевелната популација, заплевеленоста и растот на плевелите, со што се наметнува потребата од усогласување и изработување стратегија за борба против нив. Растителните остатоци влијаат врз 'ртењето на плевелите и нивните поници преку попречување на достапноста на светлината, физичкото задушување и хемиското (алелопатско) дејствување. Покривните култури се основен и одржлив начин за физичко и хемиско (алелопатско) намалување на бројноста на плевелите. Разновидноста на културите во плодоредот помага во прекинување на циклусот на пораст на плевелите и ја спречува појавата на доминација на некои плевелни видови. Хербицидите, исто така, претставуваат интегрален дел од борбата против плевелите во конзервациското земјоделско производство. Но, кога не се употребуваат во препорачаните дози или во хербициден плодоред, можат да предизвикаат загадување на животната средина, промени во плевелната популација и појава на резистентност кај некои плевелни видови.

Клучни зборови: конзервациско земјоделско производство; плевели; растителни остатоци; покривни култури; плодоред